

Analysis of NMT Users on Social, Economic and Cultural Characteristics Relating to Transport Mode System Integration

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Abstract

Walking and cycling, as non-motorized transportation (NMT), are expected to reduce transportation problems such as congestion and improve the quality of life. However, NMT has a lot of limitations such as low vehicle speed which causes time inefficiencies, low accessibility, and in-compatible with door-to-door travel. This research aims to discover the development of NMT in terms of its mode integration system and analyze the social, economic, and cultural aspects underpinning NMT's future growth. The method used in this study is analyzing conditions with descriptive analysis and mappings. The analysis reveals that around 80% of sidewalks require repair or improvement, with issues including cracked pavements and inadequate accessibility features. The study found that users primarily travel to recreation spots and city centers, with 60% of respondents expressing satisfaction with existing NMT facilities. But there is significant room for enhancement, especially in cultural and safety aspects. Notably, 40% of users indicated a strong need for better integration with public transport, emphasizing the importance of strategic bus stops and improved pedestrian pathways. Recommendations are provided for enhancing NMT infrastructure to promote sustainable urban mobility and social cohesions.

1. Introduction

Walking and cycling, as a part of non-motorized vehicles (NMT), have been a concern for developing a sustainable transport system in several countries (Ray et al., 2020). The sustainability of NMT systems and mobility with its environmental perspective is expected to reduce urban transport problems and improve the quality of urban life in communities (Zhou et al., 2020). Un-safe and inconvenient NMT facilities may lead to several environmental problems and health issues that might correspond to social, culture, and economic impacts (Zhou et al., 2020). Providing decent NMT facilities and supporting infrastructure, accompanied by NMT policies is essential to encourage sustainable transport behavior and lower congestion levels. Congestion itself is a major problem in the field of transportation, which causes many environmental and economic effects such as air pollution, economic losses due to time efficiency and travel costs, waste of fuel use sourced from petroleum, and health issues (Shelat et al., 2018). In some developed countries, several transportation policies have been implemented to improve the quality of life of their people, such as the development of NMT support facilities, public transport, bus transit systems, and private vehicle restrictions. Providing good NMT facilities, and decent

supporting infrastructure, accompanied by NMT policies is essential to encourage sustainable transport behavior and lower congestion levels (Zhou et al., 2020).

The development of NMT cannot be separated by the mode integration system. The integration of modes that harmonize the use of pedestrian facilities, bicycles, motor vehicles, and public transportation such as buses and trains is an important issue in sustainable transportation systems and travel safety (Saplioglu & Aydin, 2018). However, bicycles and private cars might operate on the same route, with different safety, and tend to lead to a performance problem because of the wrong policies of its NMT facilities and vehicle roads which reduce the time inefficiency, low accessibility, and do not accommodate door-to-door travel (Shelat et al., 2018). One of the keys to reducing the use of private vehicle modes is the integration of NMT and transit systems. The combination of active modes and high-level transit offers speed improvement, accessibility, and travel time efficiency (Shelat et al., 2018).

The concept of mode integration is part of the development of integrated areas based on transportation nodes which is part of the concept of TDM (Transport Demand Management) (Herrmann et al., 2015). Integration involves different modes of transportation, various aspects, and various activities. The transportation mode integration system can be divided into several sub-systems, namely the integration of transportation support infrastructure, integration of implementing organizations, integration of economic and financial aspects, information integration, and spatial integration (Nosal & Solecka, 2014). Nosal & Solecka 2014 research on the integration of modes of transportation involved several aspects of it, which were then analyzed using the AHP (Analytical Hierarchy Process) method for decision-making in developing a mode integration system in Cracow, Poland.

The same method was also used in Saplioglu & Aydin 2018 research in choosing bike lane routes to integrate with the public transport system. Both negative and positive parameters were used to select the route described in the questionnaire involving 460 respondents. The main criterion chosen is to avoid accident-prone locations. Other criteria are the availability of bus lanes, the availability of road body parking for motor vehicles, bicycle parking, traffic signals, road capacity, the availability of bike lanes integrated with highways, and the availability of bike lanes separate from highways. The study concluded that accident-prone locations, bus lanes, and road body parking locations for private vehicles are the most important factors in integrating bicycles with public transportation (Saplioglu & Aydin, 2018).

Sagaris & Arora, 2016 evaluated the integration between bus and bicycle transportation modes. Sagaris & Arora focuses on integrating buses and bicycles as part of a sustainable transportation system. The research was conducted using conceptual exploration, which took two case study areas, namely Delhi and Santiago. Sagaris & Arora uses a social perspective to better understand the importance of NMT on the sustainability of the transportation system. The criteria considered in this study are cycling distance, implications of transportation planning and land use, implications on the general public, urban transportation development, mode integration, travel safety, health, age, and psychological factors of transportation mode users (Sagaris & Arora, 2016).

However, these studies often focus on large metropolitan areas, whereas our research uniquely addresses a smaller urban setting, Magelang, Indonesia, where NMT infrastructure and mode integration are still underdeveloped and experienced absence of supporting infrastructure policies and the scarce of a mode integration system. Jakarta, as the capital of Indonesia is currently starting to develop NMT and a mode integration system which was driven by a severe level of congestion. Reflecting on the conditions in that capital city, the development of NMT and its mode integration system is an absolute necessity, especially in other cities in Indonesia.

This research builds on existing frameworks by applying them to a context with distinct socio-economic and cultural dynamics. The study not only assesses the technical conditions of sidewalks and bike lanes but also examines local perspectives on economic, cultural, and social aspects that influence NMT usage. In the technical aspect, mapping NMT supporting infrastructure, land inventory, and utility inventory was carried out. Relationships between networks are analyzed as part of a mode integration system that results in the development of potential points of mode integration. Economic, social, and cultural aspects are developed through questionnaire surveys and analyzed using explanatory analysis using tables and graphs. Considering these important matters, this research is expected to provide benefits to develop NMT in the mode integration system and analysis the social, economic, and culture that could encourage the development of sustainable transport system through transport mode system integration.

2. Research Method

Aspects reviewed in this study include technical, economic, cultural, social, and environmental aspects, collecting data on current conditions in pedestrian and cyclist facilities, as well as inventory surveys of supporting infrastructure, and then conducting an analysis of the data that has been obtained. The descriptive analysis and mapping were carried out to find out the current condition of NMT supporting infrastructure, the development of NMT and its mode integration system, and the analysis of economic, social, and cultural aspects that support the development of NMT, discuss research results and compile conclusions and suggestions. The

research location was divided into four streets in Magelang, namely Pahlawan Street, Tidar Street, Tentara Pelajar Street, and Pemuda Street. The research locations were chosen because it has feature dedicated lanes for NMT, which makes them ideal for studying the integration of NMT with other transportation modes, as they provide a suitable environment to observe and analyze the specific parameters related to NMT infrastructure and usage.

This study reviewed several aspects related to NMT in the mode integration system. From economic aspects, it is discussed the influences that can arise and rise from the activities of pedestrians and cyclists. The aspects reviewed are the influence on the surrounding shops and on street vendors. Cultural aspects are reviewed based on the study of pedestrian and cyclist facilities closely related to the existence of local cultural buildings, such as the presence of trees, park benches, and others. The social aspect reviewed is the potential for increased social activities such as opportunities to meet each other among users of public facilities and public transportation.

From the 4 aspects of the review, several surveys were conducted that supported the application of its elaboration as seen in Table 1.

Table 1 Research survey

Survey Type	Description	Data Collected
Infrastructure Inventory	Field survey on facility dimensions, condition	Sidewalk size, slope, material, facility condition, utilities
Infrastructure Utilization	Survey of pedestrian and cyclist usage, demand points, and supply potential.	Demand and supply potential points
Community aspects	Questionnaire on resident characteristics and socio-cultural impacts on facility usage.	Resident characteristics, socio-cultural impacts, economic effects
Public transport network	Transit and integration points	Transit and integration points

Data were collected through field observations and questionnaires distributed to facility users, capturing dimensions, conditions, and user experiences. Additionally, surveys assessed the influence on surrounding businesses and social impacts. The study followed relevant regulations, including Indonesia's Road Traffic and Transportation Law (2009) and guidelines for pedestrian and cyclist safety as specified by the Ministry of Public Works and Housing Number 02/SE/M/2018 by the Ministry of Public Works and Housing (PUPR, 2018), and the Regulation of the Minister of Public Works Number 03/PRT/M/2014 (PUPR, 2014) on Guidelines for Planning, Provision, and Utilization of Pedestrian Infrastructure and Facilities in Urban Areas.

3. Results

3.1 Existing Condition of NMT Facilities

Inventory surveys have been conducted on all four sections of the road that were reviewed to identify the good/poor condition of the supporting infrastructure of pedestrian and cyclist facilities. Inventory surveys are conducted to see the condition of sidewalks (left and right), support facilities, slow lanes and crossing facilities. Each section of the road has sidewalks on both sides. The length of each road according to data from the Magelang Public Works and Spatial Planning Department is 858 meters long on Pemuda Street, 588.7 meters on Tidar Street, 985 meters on Tentara Pelajar Street, 2120 meters on Pahlawan Street.

From the survey, it can be obtained that the width of the existing sidewalk along Pemuda Street on the right side is 2.5 m while on the left side, it is 6 m. The materials used for the sidewalk on the right side are ceramics, while on the left side are ceramics and paving blocks.

Meanwhile, the width of the existing sidewalk along Tidar Street on the right side varies from 2.25 to 2.5 meters; while on the left side also varies from 1.7 m to 2.10 m. The material used for the sidewalk on the right side is ceramic; while on the left side is paving blocks. Between the road and the sidewalk with the bicycle lane there is a concrete separator.

On the left and right sidewalks there is some damage in the form of damage to the sidewalk floor, loss of part of the sidewalk floor, and the closure of the sidewalk by trees. Of the entire road segments reviewed, the majority of the replacement is needed in the form of replacing tiles that are segmented on certain spots. The conditions are quite good on the Pahlawan Street, and just the small part of its sidewalk is experiencing damage.

Sidewalk support facilities located on the segments reviewed include seating, sidewalk lights, trash cans, bicycle lane signs, bicycle emblem markings, and bicycle lanes, while on the right side of the sidewalk there are only steering tiles and trash cans.

The width of the existing sidewalk along the Tentara Pelajar Street on the right side varies from 1.8 m to 2.15 m, while on the left side it is 1.7 m. The material used for both the sidewalks on the right and left sides is

ceramic. There are also concrete separators which are located between the road and the sidewalk. On the left and right side-walks there is some damage on the floor, loss of part of the sidewalk floor, and the closure of the sidewalk by trees.

The width of the existing sidewalk along Pahlawan Street on the right side varies from 1.0 to 1.7 meters; while on the left side also varies from 1.5 to 2.5 meters. The materials used on the right and left sides are ceramic and paving blocks. Between the road and the sidewalk and the slow lane there is a separator in the form of a concrete.

Of the entire road segments reviewed, the majority of the replacement is needed by replacing tiles that are segmented on certain spots. The conditions are quite good on the Pahlawan Road, and not the entire sidewalk is damaged. Along the road segments reviewed there are supporting facilities in the form of stops or waiting stalls. Road crossing facilities in the form of Zebras Cross which at some points are equipped and not equipped with Traffic Signaling Devices or pelican crossings.

3.2 Potential Locations of Demand and Supply

A survey of potential points of demand and supply to NMT users has been conducted. The survey was conducted based on the NMT users' experiences. It also referred to the Regulation of the Minister of Public Works Number 03/PRT/M/2014 on Guidelines for Planning, Provision, and Utilization of Pedestrian Infrastructure and Facilities in Urban Areas. From the results of the survey, the supply point varies and can be categorized into recreation areas (parks, squares). Most of it comes from their homes. Some travel from places of worship (mosques and churches). Potential demand points also vary, some for recreation or sports, such as parks. While other demand points also vary, from places of worship (mosques and churches), schools, shopping places (markets and supermarkets) and places of work.

Table 2 Supply and demand potential points

No	Address	Supply Potential Points	Demand Potential Points	
1	Potrobangsari	North Magelang	Tuguran	Supermarket
2	Ngepanrejo	Bandongan	A Yani Park	Mosque
3	Potrobangsari	North Magelang	A Yani Park	Mosque
4	Tirtosari	Sawangan	School	Badaan Park
5	Ngrapah	Banyubiru	Mosque	Badaan Park
6	Kramat Utara	North Magelang	A Yani Park	Badaan Park
7	Kedungsari	North Magelang	City Center	City Center
8	Tidar Utara	South Magelang	Home	Pasar
9	Banyubiru	Dukun	Muntilan	City Center
10	Banyubiru	Dukun	Muntilan	City Center
11	Sukorejo	Mertoyudan	City Center	Masjid
12	Mid Magelang	Magelang	Rumah	City Center
13	Magersari	South Magelang	Rumah	City Center
14	Tidar Selatan	South Magelang	Rumah	City Center
15	Banjarnegoro	Mertoyudan	Magelang Suburb	City Center
16	North Magelang	North Magelang	Home	Army Park
17	Kemirirejo	Magelang	Home	School
18	South Jurangombo	South Magelang	Hospital	Traditional Market
19	Banjarnegara	Mertoyudan	Home	City Center
20	Kantil	Mid Magelang	Curch	Home
21	Banjarnegoro	Magelang Suburb	Home	Army Park
22	Magersari	South Magelang	Home	City Center
23	Gelangan	Mid Magelang	Curch	Home
24	Srangseng	Kembangmu	Curch	Hospital
25	Gelangan	Mid Magelang	Curch	Home
26	Gelangan	Mid Magelang	Home	Tempat Kerja

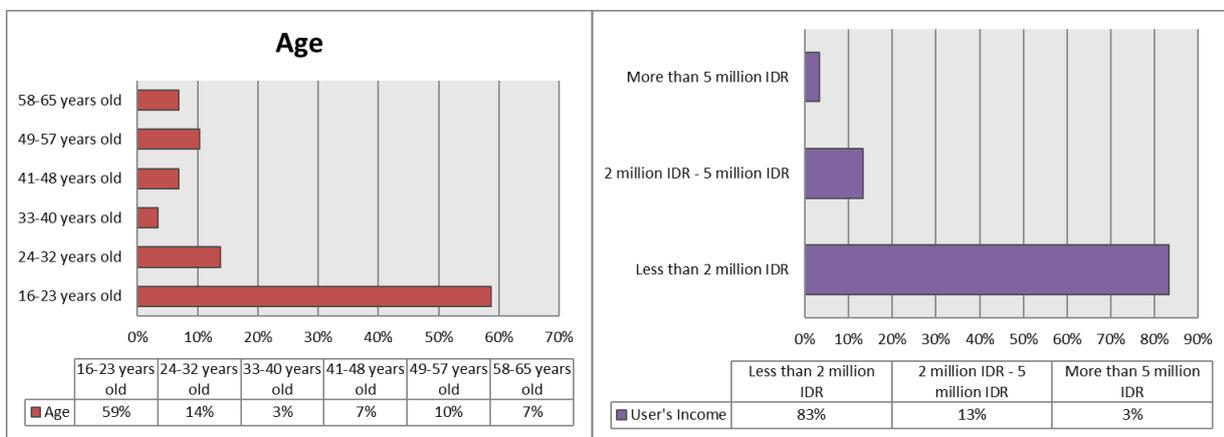
No	Adress	Supply Potential Points	Demand Potential Points
27	Sumberejo	Mertoyudan	Magelang Suburb
28	Magersari	South Magelang	Home
29	Sumberejo	Mertoyudan	Pandansari
30	Wonokerto	Tegalrejo	Wonokerto

The data shows a structured network of supply and demand points across Magelang and its suburbs, with key resources like supermarkets, schools, mosques, parks, and city centers highlighting North and South Magelang as vital regions. Suburbs like Banyubiru and Mertoyudan also demonstrate active supply and demand patterns, reflecting their integration into the metropolitan area. The frequent mention of mosques and parks underscores the community’s emphasis on religious and leisure spaces, while city centers are hubs for social and economic activities. This balance of resources suggests that urban planning should align with these dynamics to support a cohesive and sustainable environment, enhancing residents’ quality of life by meeting local needs effectively.

3.3 Analysis of Economic, Social and Cultural Aspects That Support the Development of NMT the Future

3.3.1 User Characteristics of NMT Facilities

The economic, social, and cultural aspects are assessed by analyzing questionnaire results from users of sidewalks and bike paths, specifically targeting Non-Motorized Transport (NMT) users. The economic aspect focuses on users’ perceptions regarding the presence of local shops and supermarkets, their freedom to view storefronts, and views on the development of supporting facilities for sidewalks and bike paths. The cultural aspect examines users’ perceptions of supporting features such as pedestrian walkways, bike lanes, road markings, curbs separating pedestrian and vehicle lanes, and street lighting for NMT users. This provides insights into how well these elements meet user needs and contribute to the local environment. The social aspect investigates users’ perceptions of how these facilities promote social interaction opportunities, such as the likelihood of spontaneous encounters and interactions among public facility users, including those using public transportation. This aspect helps to understand the potential for social activities and connectivity among community members. Data analysis involves responses from both questionnaires and interviews, which include a structured list of questions. The responses are then presented in estimated response bar charts to visually summarize the findings. Based on the results of the questionnaire survey, user characteristics, including age distribution, gender, occupation, and income, were analyzed and are presented in Fig. 1. The survey involved a total of 40 respondents (N = 40).



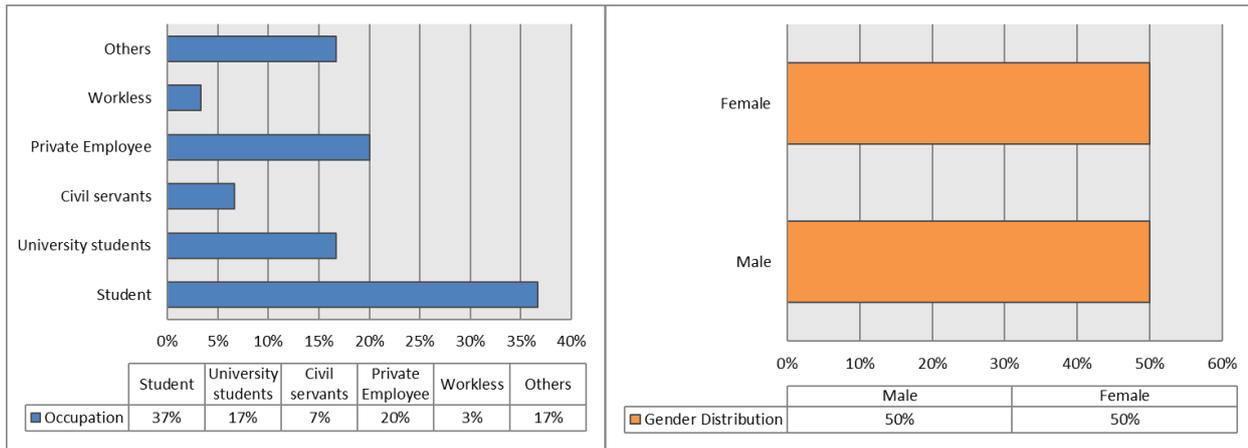


Fig. 1 User characteristics

From the bar chart, it can be seen that users of NMT facilities come from a fairly varied age range, but users are at most 16-24 years old. By gender, male users are just as numerous as female users. The type of user's work also varies, with students having the largest percentage at 36% and the smallest not working as much as 3%. Since most users are school students, while some are university students, The income distribution data also indicates that 84% of NMT facility users earn less than two million rupiah per month, which is considered low income in Indonesia. In addition, it is also reviewed the frequency and characteristics of NMT facility usage shown in Fig. 2.

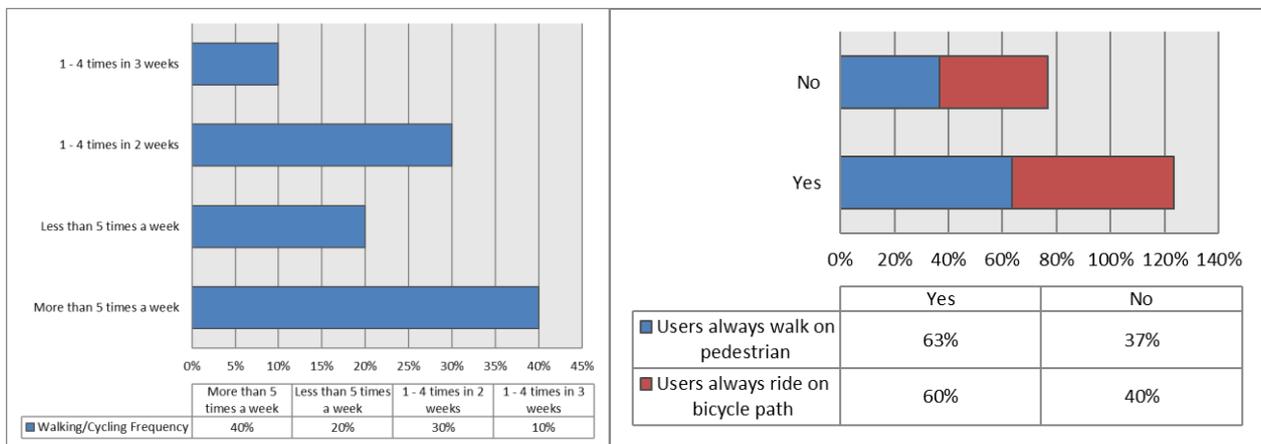


Fig. 2 Frequency and use of user NMT facilities

From the image above, the frequency of users in walking or cycling varies. Nevertheless, most respondents more than 5 time a week travelled on foot or cycling. Half of the respondents also cycled less than 5 times a week and 1-4 times in 2 weeks. Meanwhile, the majority of respondents also used sidewalks and bike lanes.

3.3.2 User Perception of Economic Aspects of NMT Facilities

As discussed earlier, that economic aspect is related to the existence of street vendors, storefronts, and the development of supporting facilities. A bar chart showing the results of the analysis is shown in the Fig. 3.

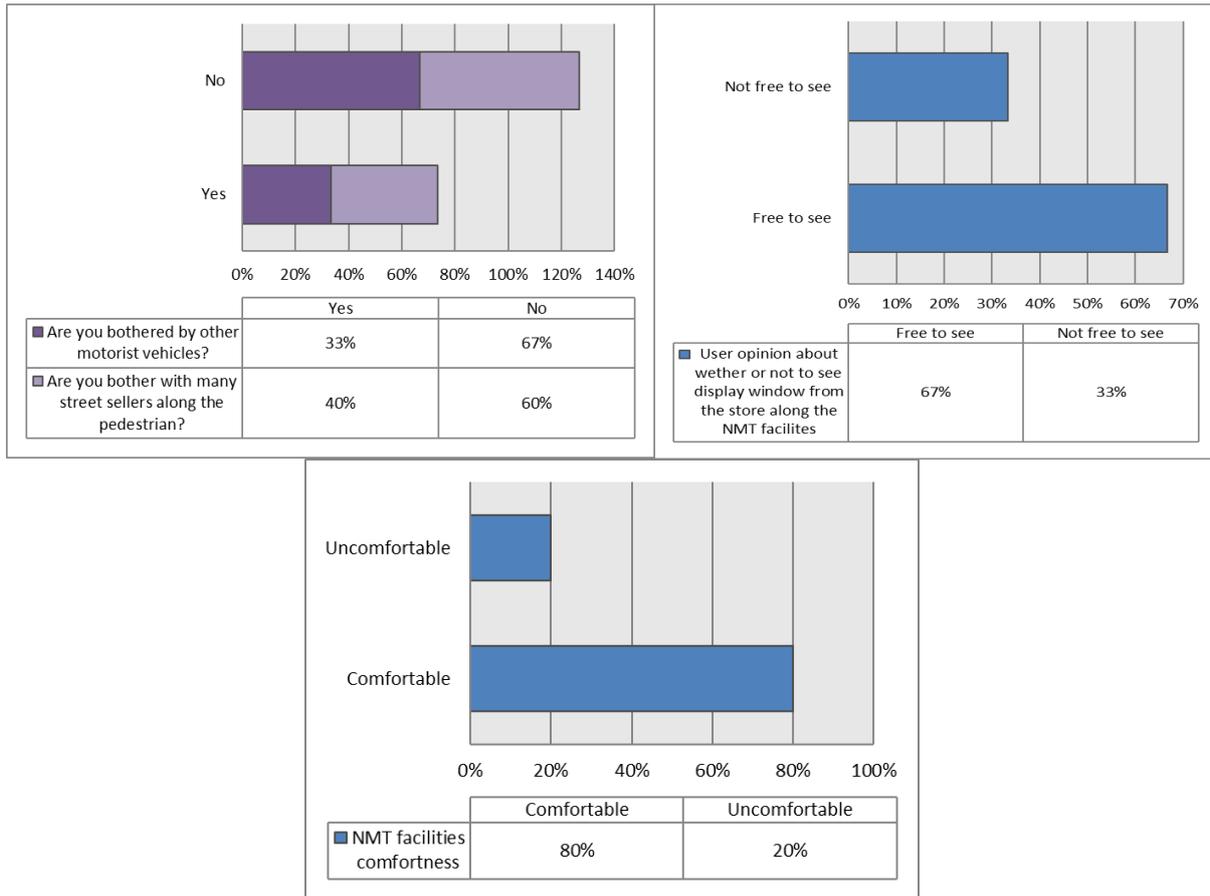


Fig. 3 Economic aspects based on user perception of NMT facilities

The charts reveal that 33% of users are uncomfortable with cars and 40% with street vendors near NMT infrastructure, suggesting potential challenges for local businesses. Although vendors support the economy, user discomfort may deter foot traffic and impact sales. Additionally, 67% of users feel free to view retail displays, benefiting businesses, but 33% feel obstructed, indicating a need for better infrastructure planning to enhance visibility. Notably, 80% of users find NMT facilities comfortable, which could boost local business by attracting more foot traffic, though the 20% who are uneasy should be addressed to ensure a positive user experience that promotes spending.

3.3.3 User Perception of Cultural Aspects of NMT Facilities

The cultural aspect is focused on the user's perception of the excision of existing buildings. The emphasis on the excision of this building is that, if later completely changed, it will affect the culture of the local community both specifically and in general.

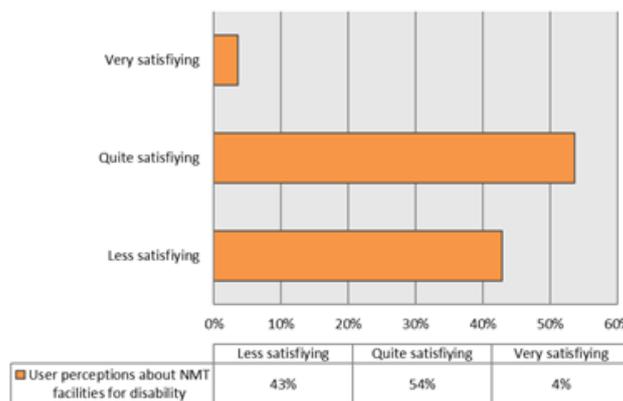


Fig. 4 Cultural aspects based on user perception of NMT facilities

Based on the results of data analysis, it turns out that almost all users stated the need to maintain green open space facilities and seating along the road passed. Meanwhile, the current disability facilities need to be improved, because only 3% of respondents are satisfied with this facility.

3.3.4 User Perception of Social Aspects of NMT Facilities

The social aspect is reviewed by emphasizing the aspect of interaction between NMT facility users. The results of the analysis can be seen in the image below.

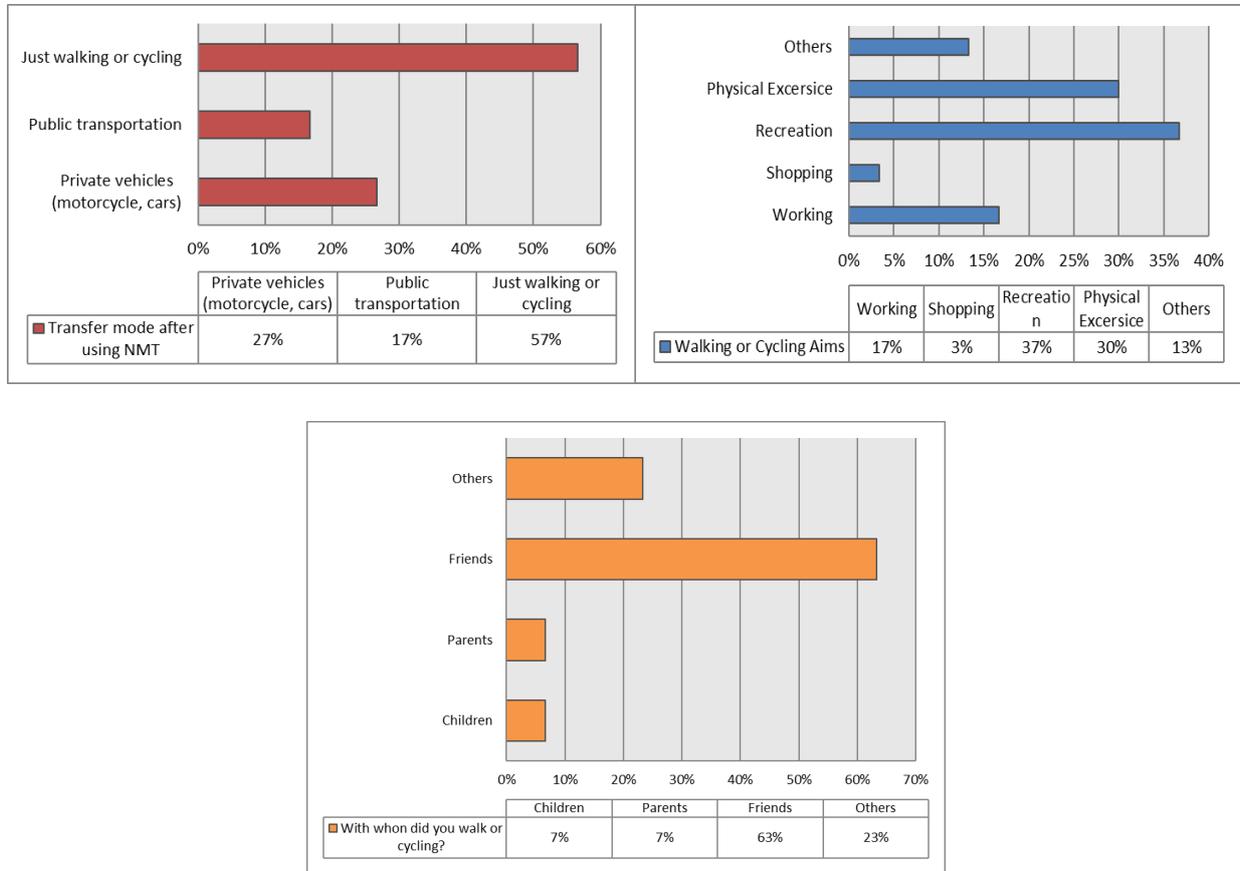


Fig. 5 Social aspects based on user perception of NMT facilities

Before heading to the location of the road passed when conducting a survey, some users are indeed just walking or cycling from the origin. Users aim mostly for leisurely or recreational walks and exercises. More than half of the respondents did their activities with peers. Some are alone (below 23%). This indicates the potential for increased social interaction if there is an increase in NMT facilities because most users only use NMT facilities and together with their peers in activities.

3.3.5 User Perception of Safety Aspects and Development of NMT Facilities

To complement the overall aspects of local wisdom in this study, the safety aspect is also reviewed in this sub-chapter. In addition, an analysis of respondents' opinions was conducted about the development of existing facilities and expectations in the future.

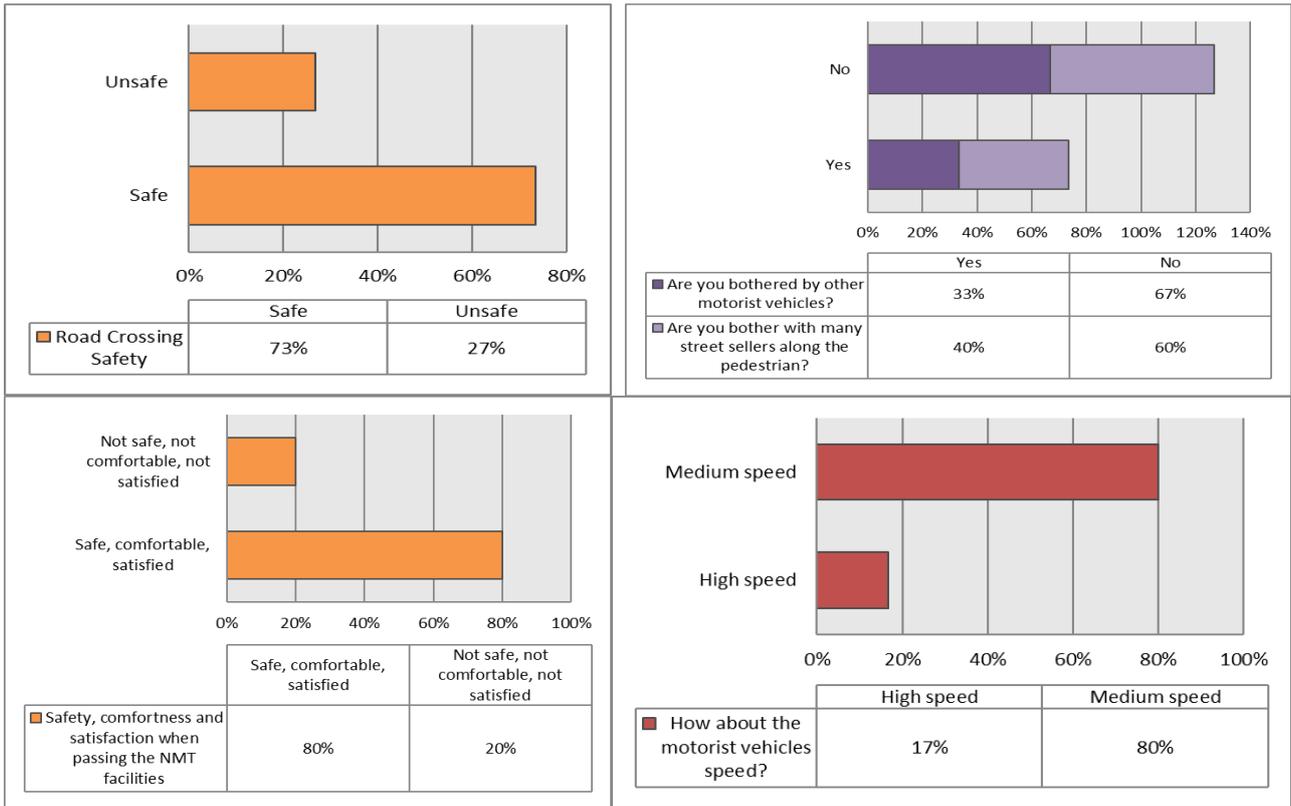
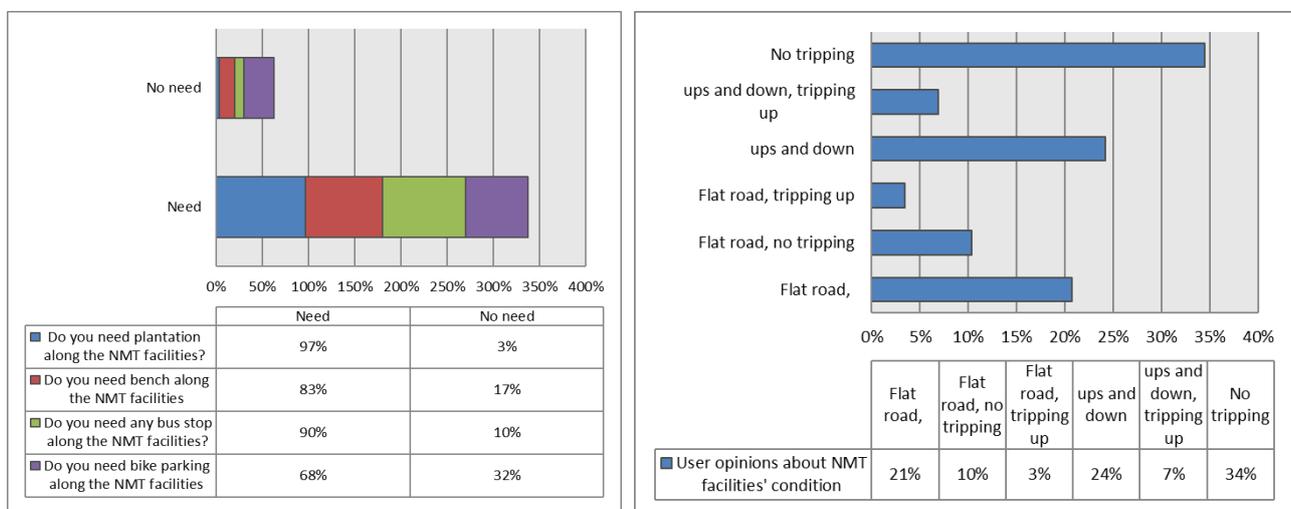


Fig. 6 Safety aspects based on user perception of NMT facilities

Based on Fig. 6, most users feel safe in crossing the road. However, there are also those who still feel unsafe because of the presence of motor vehicles driving their vehicles at high speeds, the number of motorcycles passing through the sidewalk or slow lane, and pelican crossings are still limited. However, some users feel undisturbed by the presence of NMT vehicles. According to users, the majority of motor vehicles pass at a moderate speed. In general, it can be seen that users feel safe, comfortable and satisfied with the division of space between pedestrians / cyclists and motor vehicles. The impact on the existence of NMT facilities and their development potential can be seen in the Fig. 7.



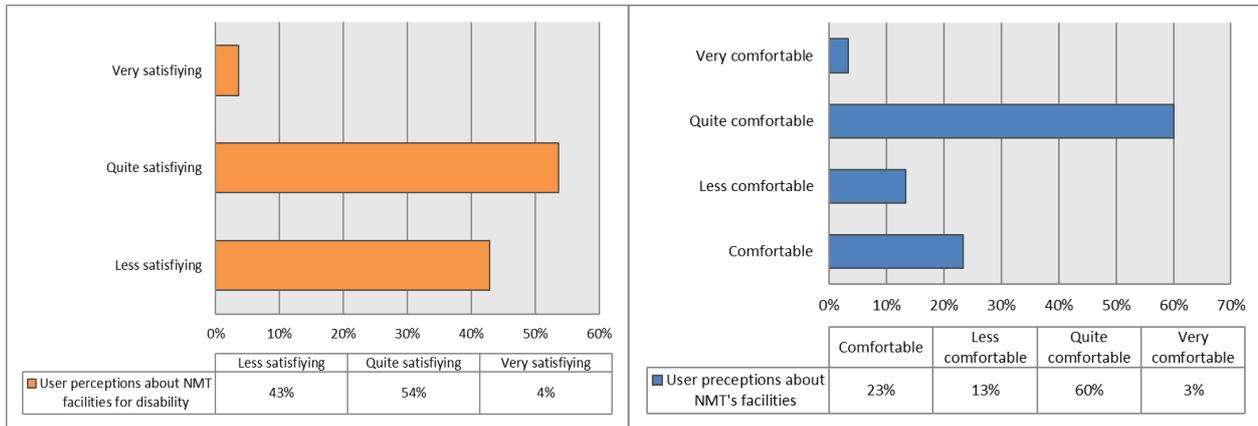


Fig. 7 User perception of NMT facilities

Most users argue that the existence of NMT support facilities such as stops, bicycle parking, seating is needed to support comfort and effectiveness in traveling on foot or cycling. Meanwhile, according to users, facilities such as pedestrian paths, cyclists, markings, separators between NMT user lanes and the major road and street lighting facilities are quite comfortable, although 14% still think it is not comfortable. For the condition of the facilities passed, respondents' answers varied. Road conditions are quite good with elevations that do not go up and down and do not tripping. But there are still 31% of respondents who think that the vertical road alignment has a tripping hazard. The existence of disability facilities according to some respondents is quite satisfactory, which means that it needs to be improved so that most respondents are satisfied or very satisfied with this disabled facility. Based on user feedback, the primary expectation for NMT facility upgrades is a reduction in air pollution, cited by 40% of respondents. Additionally, 17% of users expect improvements that would enhance road user interactions, while 13% emphasize increased social interaction among road users. About 10% anticipate that improved NMT facilities will facilitate easier access to public transportation, contributing to better connectivity. Some respondents (10%) also hope that upgrades will enhance recreational opportunities. These findings indicate that environmental improvements and enhanced accessibility are the top priorities for users.

3.4 Study of Mode Integration System

The study of the mode integration system was carried out by conducting a survey of public transport network relationships. In the survey, data collection was carried out on the location of stops, transit points of public transportation and integration points of public transportation. Based on the survey results, along Pemuda Street there are no stop facilities, on Tidar Street, Tentara Pelajar Street, and Pahlawan Street the existing stop has not worked optimally and has not provided comfort to public transportation users.

Based on the survey on the public transport network integration system assessed stop locations, transit points, and integration points along Pemuda, Tidar, Tentara Pelajar, and Pahlawan Streets. Findings revealed a lack of stops and bicycle parking facilities on Pemuda Street, while existing stops on other streets were underutilized and uncomfortable for users. Stop placement recommendations were based on transit activity: Pemuda Street will have three stops at 200-300 m intervals near dense activity centers, such as markets. Tidar Street requires only repairs to existing stops within the 200-400 m range, where transit activity is highest. Tentara Pelajar Street will see three new stops spaced at 400 m intervals to serve offices, schools, and services. Similarly, Pahlawan Street will add stops between 300-400 m to align with land use patterns. This placement follows the Pedestrian Facilities Technical Planning Guidelines, which suggest a maximum 400 m walking distance for accessibility. Wijaya's (2021) findings on ideal stop placement within a 400–600 m radius for mixed-use areas further supports these recommendations. Planned stop types vary, with Type 2 for Pemuda and Type 1 for the other streets, following the Technical Guidelines for Public Passenger Vehicle Stops.

The planned stops consider these findings to ensure that transit facilities are optimally located for both convenience and land use efficiency in areas with dense activity centers and institutional buildings. The type of stop used for the Youth Road section is a type 2 stop, while for Tidar Street, Tentara Pelajar Street, and Pahlawan Street used type 1. The length of the stop is 4 m and has a width of 2.20 m, in accordance with the Decree of the Director General of Land Transportation No. 271 / HK.105 / DRJD / 96 concerning Technical Guidelines for Engineering Public Passenger Vehicle Stops.

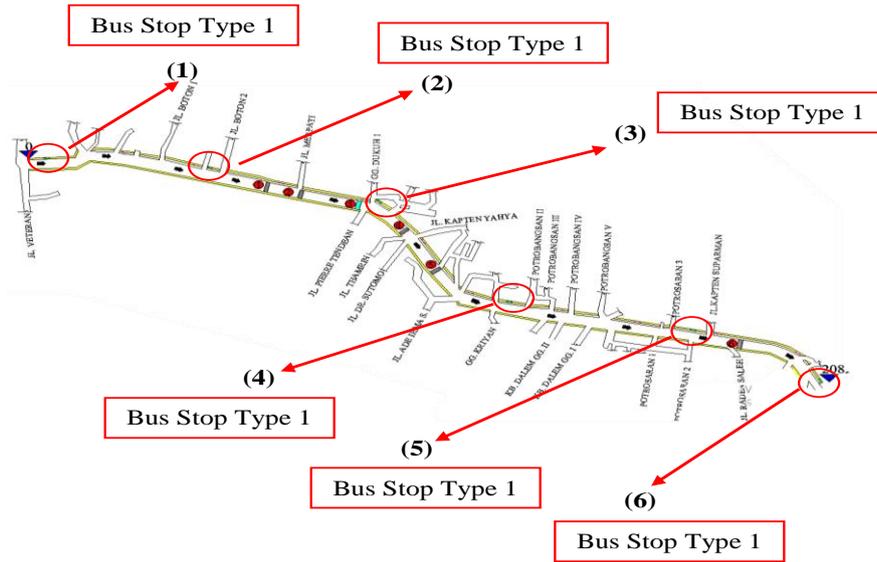


Fig. 8 Potential bus stop development in Pahlawan Street

Bicycle parking is planned to use type N, because based on PUPR Guideline 07/P/BM/2023 The Design of Bicycle Facilities this type has a high level of safety when compared to other types. Bicycle parking is planned to be located on the green lane. The distance of the placement of bicycle parking on Pemuda Street, Tidar Street, Tentara Pelajar Street, and Pahlawan Street is planned every 200 m with the addition of ramps between bicycle parking lots making it easier for bicycle users to access bicycle parking lots and bicycle lanes. On the bicycle lanes on Pemuda Street, Tidar Street, Tentara Pelajar Street, and Pahlawan Street are also equipped with bicycle lane signs at the beginning of the sidewalk, and bicycle mark, as well as longitudinal markings on road openings.

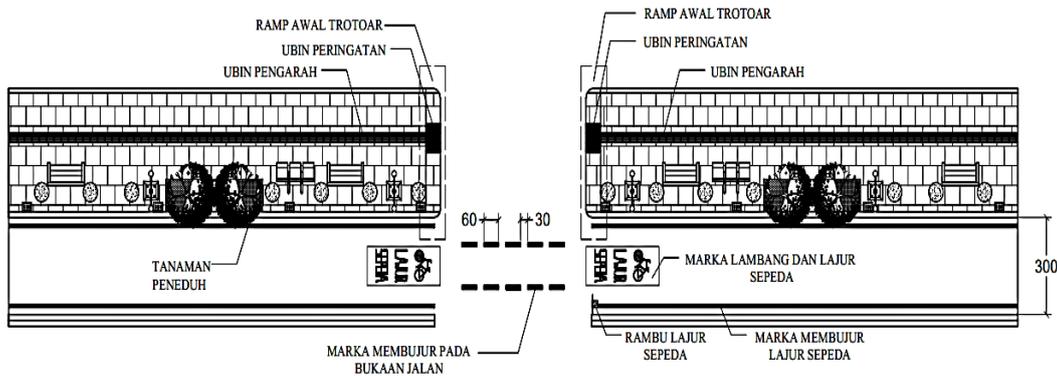


Fig. 9 Cycling lane detail (PUPR Guideline 07/P/BM/2023)

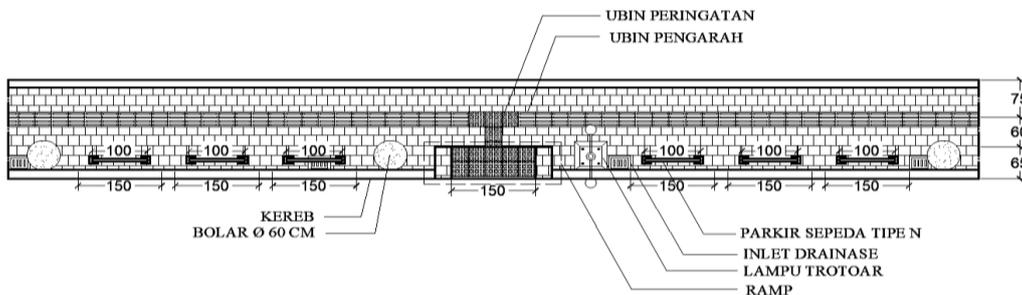


Fig. 10 Bicycle park (PUPR Guideline 07/P/BM/2023)

4. Conclusions

The conclusion obtained from this study is that the conditions of NMT support infrastructure reviewed are sidewalks and slow lanes. Based on the results of the survey, along the sidewalks on the left and right sides of The Youth Road, along 800 meters, there are damaged sidewalk sections per 200 meters of road. Meanwhile, on Tidar road, there is damage from sta 0+000 to 0+520 on the left and right sides. Almost even damage on the sidewalk is also found on the road of the Student Army. Meanwhile, on Hero Street, damage occurred ranging from sta 0+800 to sta 2+082. This pavement damage needs to be dealt with the repair of damaged parts, such as ceramics or pavement paving. Meanwhile, most of the sidewalk and slow lane support facilities, such as seating, sidewalk lights, trash cans, bicycle lane signs, bicycle lane markings, bicycle lanes and steering tiles are mostly appropriate, only the placement distance is not appropriate.

The development of NMT facilities is carried out by calculating the minimum effective width of the pedestrian facilities required based on the number of pedestrians and the additional width required based on its land use function. On the left side of Pemuda Street, it is necessary to make adjustments between sidewalk and slow lane facilities that are currently in a mix-traffic condition, but the right side remains. Meanwhile, on Tidar Street, the left side needs to be widened, the right side remains. On the road of the Tentara Pelajar, it is necessary to widen the left sidewalk, and the right side remains. Meanwhile, it is necessary to widen the right side of the sidewalk and the left side of the sidewalk on Pahlawan Street. Also needed is the repair of the sidewalk floor, the addition of pedestrian support facilities in the form of ramps at the beginning of the sidewalk, trash cans, sidewalk lights, steering tiles, warning tiles, drainage inlets, green lanes, and bicycle lane facilities on almost all roads re-viewed.

The study of the mode integration system based on the results of the transportation transit point survey on Pemuda Street, is planned to build 3 stops with a distance of 200-300 m for areas with land use in the form of very dense activity centers (markets and shops). While on Tidar Street, the most public transportation transit is located at a point of 200-400 m where there are stop facilities so there is no need to add stops only needed to repair existing stop. On Tentara Pelajar Street, a stop is planned to be 400 m away for areas with land use in the form of offices, schools, and services. Pahlawan Street is included in the area with land use in the form of offices, schools, and services, so the placement distance ranges from 300-400 m. The stop is planned without using the bus bay due to the lack of available area. The type of stop used for the Pemuda Street section is a type 2 stop, while for Tidar Street, Tentara Pelajar Street, and Pahlawan Street used type 1 stop. The length of the stop is 4 m and has a width of 2.20 m, in accordance with the Decree of the Director General of Land Transportation No. 271 / HK.105 / DRJD / 96 concerning Technical Guidelines for Engineering Public Passenger Vehicle Stops.

Analysis of economic aspects results in most users not being disturbed by the presence of street vendors in NMT facilities that they pass through. The majority of users also feel free to see the storefront on the left or right of the road passed. Almost all respondents state that the existing facilities are already comfortable. Judging from the cultural aspect, it turns out that almost all users stated the need to maintain green open space facilities and seating along the road passed. From the social aspect, some users are just walking or cycling from their origin. Users aim mostly for leisurely or recreational walks and exercises. More than half of the respondents did their activities with peers. Some are alone (below 23%). This indicates the potential for increased social interaction if there is an increase in NMT facilities, because most users only use NMT facilities and together with their peers in activities. Based on the results of the survey, users hope that the decrease in air pollution levels will be increased later NMT facilities (40%). Meanwhile, users also want an increase in encryption between land users along with a decrease in air pollution levels (14%). Other respondents hope that if the facilities are improved, it can increase the potential of recreation, and can access public transport more easily.

Policies should also incentivize local businesses to enhance storefronts without obstructing pathways, fostering social and economic benefits. Traffic calming measures, such as speed bumps and pelican crossings, are recommended to ensure pedestrian safety. The city's planning departments should adopt data-driven tools like GIS for continuous NMT facility assessments, ensuring that future developments align with user needs and promote sustainable transport. By implementing these actions, local policymakers can enhance NMT infrastructure in Magelang, creating a safer, more accessible, and inclusive urban environment.

From the research that has been done, it is recommended that further research delve deeper into specific aspects of intermodal integration systems, such as the spatial alignment of NMT facilities with public transit stops to optimize user accessibility and convenience. Software such as Arc GIS for detailed spatial analysis can enhance the precision of such studies, while agent-based models or travel demand models could simulate user behavior and mode choice patterns under different integration scenarios. These tools can provide valuable insights into how different transport modes interact, aiding in the development of data strategies for NMT infrastructure planning.

5. Online License Transfer

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Conflict of Interest

All authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors contributed to the work as follows: study conception and design: Evi Puspitasari; data collection and processing: Desty Aviani; analysis and interpretation of results: Evi Puspitasari, Fajar Susilowati; manuscript drafting: Evi Puspitasari, Fajar Susilowati. All authors have reviewed and approved the final version of the manuscript.

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